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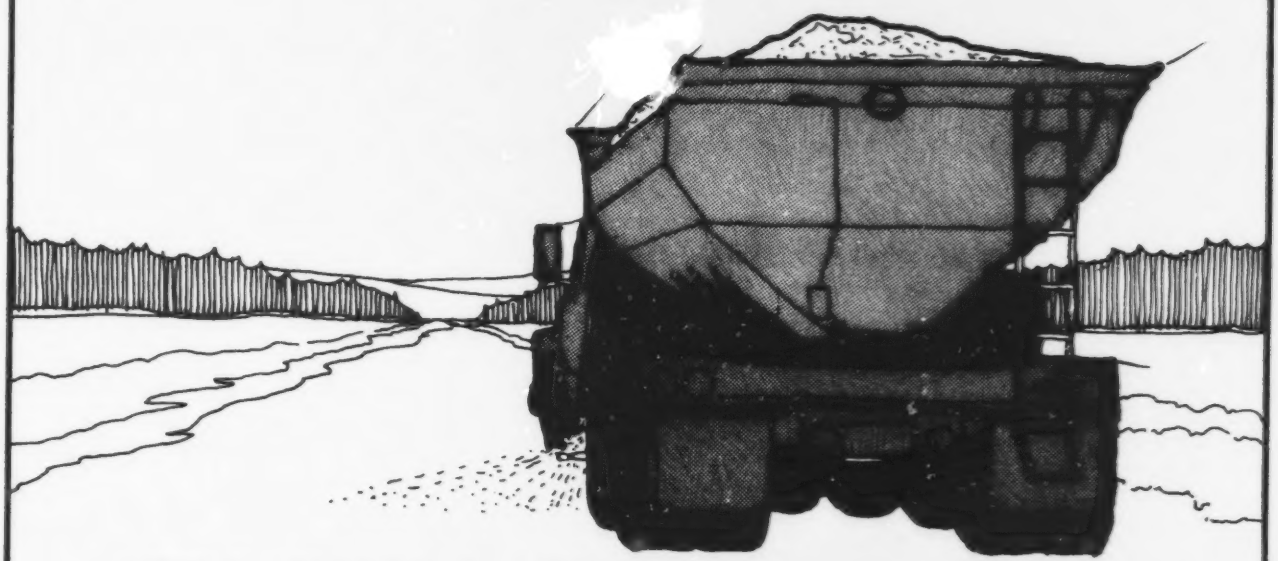

CALCIUM TREATED SAND

A REPORT ON THE USE OF CALCIUM CHLORIDE TREATED SAND AND SALT ON A MINISTRY HIGHWAY DURING THE WINTER OF 1982-83.

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INTRODUCTION:

As part of its mandate to determine effective and efficient methods for Winter maintenance snow and ice control, the Maintenance Branch of the Ministry of Transportation and Communications evaluates methods and procedures both within the Ministry and other agencies.

A growing interest amongst municipal governments in the benefits of Calcium Treated Sand (CTS), prompted the Maintenance Branch to undertake a controlled study of calcium treated sand to evaluate the effectiveness of CTS as a practical alternative to current MTC mixes.

This report describes that study, which took place during the winter of 1982-83.

THE CONCEPT

CTS is a concept marketed by Allied Chemical Canada Ltd. It includes a program of mixing various quantities of sand, salt and calcium chloride solution into a homogeneous mixture. Allied Chemical, in its promotional literature, lists a number of benefits of CTS, among them being, "better traction, faster return to bare pavement and safer motoring .... at less cost".

THE OBJECTIVES OF THE STUDY

The project objective was to determine whether or not sufficient benefits would be forthcoming by using Calcium Treated Sand (CTS) as a replacement for the Ministry's current sand/salt mixes (MTC). The demonstration attempted to show that CTS:-

(a) would maintain existing levels of service at reduced cost; or

(b) improve levels of service at current costs, while

(c) reducing the overall use of chlorides (specifically sodium chloride).

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DEMONSTRATION CRITERIA

In advance of any testing, a number of concerns were addressed to ensure that consistent and comparable results would be obtained. Also, attempts were made to reduce the number of variables which might affect the results of the study.

The important concerns were categorized as follows:

(a) Location of demonstration site
(b) Resource requirements
(c) Interaction between project personnel and patrol personnel
(d) Mixes
(e) Application rates
(f) Data acquisition and analysis

(a) Location of Demonstration Site:

A list of ideal location characteristics was developed. A search was then made to select a patrol which satisfied all or most of these characteristics:

(i) within a snowbelt;
(ii) centrally located Patrol Yard;
(iii) test and control section on same highway;
(iv) highway exhibit similar physical features along its length;
(v) highway which experiences similar weather conditions along its length;
(vi) traffic volumes similar on test and control sections;
(vii) availability of Ministry construction personnel to assist in data acquisition and evaluations;
(viii) cooperative patrol staff, willing to experiment.

Patrol 6 in Owen Sound District, located at Durham, Ontario, best met the criteria. A description of this patrol is found in Appendix I.

Within this patrol, three short sections on each of the larger test and control sections were designated as observation points. These are described in Table 1.

(b) Resource Requirements:

In order to document complete storm situations, MTC staff were assigned on a full-time basis at Durham. Their specific function was to photograph the storm's course and impact, as well as to document their observations in a consistent manner.

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(b) Resource Requirements (Cont'd...)

One Regional Construction person, residing in Durham, and two members of Maintenance Management, were "on-call" during the entire demonstration project (Jan 4th to Feb. 25th, 1983).

(c) Interaction between Personnel:

The observers did not become involved with the day-to-day operations of patrol staff or supervisors. The only constraint placed upon patrol staff was that CTS only, was to be applied on the test section.

(d) Mixes:

MTC: The patrol yard contained ample covered storage for all the mixes. One dome contained a regular MTC mix of sand and 5% salt, and a salt shed contained coarse crushed sodium chloride.

CTS: A second dome was reserved to contain the CTS mix. Discussions with Allied Chemical personnel determined that the CTS mix should be proportioned with 75% sand and 25% salt by weight, mixed with approximately 6 gallons of liquid calcium chloride per ton (30.0 litres/tonne).

The mix proportions, as well as the degree of mixing, are significant and are pertinent to the results of this demonstration.

(e) Application Rates:

MTC: The rates of application of winter mixes are well documented for MTC staff. However, discussion with patrol and district personnel reinforced the following rates:

- salt (sodium chloride), only, at 130 kg/2Lkm (450 lbs/2Lm)
- sand + 5% salt at 570 kg/2Lkm (2000 lbs/2Lm)

It was also noted that occasions existed where a 'sweetened' mix was used at the end of a storm:

- sand + 33% salt at 570 kg/2Lkm

CTS: Again, from discussions with Allied Chemical personnel, the recommended rates of application for this test were determined as 280 kg/2Lkm (1000 lbs/2Lm), initially, reducing gradually to some lower rate (168 kg/2Lkm or 600 lbs/2Lm).

This also is significant and pertinent to the results of this demonstration.

To test the cost objective of this study, a cost analysis was also performed to determine which application rates of CTS were equal to the MTC mixes. This information is shown in Table 2.

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(f) Data Acquisition and Analysis:

A document was developed upon which observers noted all observations (See Appendix II). This documentation was supplemented by photographs.

Samples of the CTS mix were also taken at various intervals to further evaluate the percentages of sand and salt content (See Table 3).

All documentation was subsequently reviewed and comparisons were made, where possible.

In addition, attempts were made to measure such items as road surface temperature changes, slipperiness, and correlate chloride spray in adjacent fields with chloride applications. However, the data was such that conclusions could not be made relative to the objectives of this demonstration.

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OBSERVATIONS

A number of concerns are documented from which the success of this demonstration must be tempered.

(1) Mixing Procedure:

A description of the mixing method is found in Appendix III.

The method used by the contractor did not result in a uniform mix of the sand, salt and calcium chloride, as desired by Allied Chemical. Layers of salt were noted in the material pile. Test samples of the mixture confirmed wide variations in the percentages of contents (See Table 3).

The ideal CTS mix should have contained a homogeneous mix of 75% sand, 25% salt, plus 30 litres liquid calcium chloride per tonne. District records show that the actual mix stockpiled contained 81% sand, 19% salt, plus 30 litres liquid calcium chloride per tonne.

(2) Weather:

The traditional winter weather did not come to pass during 1982-83. Instead of the usual large quantities of snowfall and accumulations, there was mostly wet snow which dissolved soon after the storm ended. Temperatures also remained around the freezing mark. This unique situation lent itself to using more material during storms to maintain safe driving conditions.

Also, where it was expected that similar weather conditions would prevail over the entire patrol test highway, such was not the case. Documentation showed that the control section received less accumulations, and the temperatures were 2 to 3 degrees warmer than reported on the test section. The test section itself experienced two different weather patterns. More snow was recorded in the northern portion, while the southern portion had much the same as the control section (except for somewhat lower reported temperatures).

(3) Application Rates:

The initial rate of application of CTS was 280 kg/2Lkm (the settings on the spreader unit actually yielded an application rate of 277 kg/2Lkm). This rate did not produce results expected or desired by patrol staff. Analysis of observers' data also revealed that surface conditions on the test section were not similar to those found on the control section.

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(3) Application Rates: (Cont'd...)

The application rate for the remainder of the demonstration was increased to 344 kg/2Lkm, which resulted in conditions the patrol was willing to accept.

It should be noted that the CTS did show performance at 277 kg/2Lkm. However, salt applied on the control section generally worked faster and placed the road in a dry condition sooner.

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CONCLUSIONS:

1. **The CTS mix used in this demonstration did not contain the percentage of sand and salt desired, and was not uniformly mixed.**

   Calculations showed that the method used to mix the CTS did not yield a 25% content of salt. As well, observation and sample testing showed different concentrations of sodium chloride throughout the pile.

2. **The weather was not typical of the norm.**

   The demonstration period received more rain and sleet and less accumulations of snowfall than previous years.

3. **The test patrol did not always receive similar weather conditions throughout, as was anticipated. The test section itself experienced two types of patterns, which reduced the number of times CTS could be compared with MTC mix.**

   However, winter manifests itself in many ways, and a CTS mix, for it to be acceptable as a substitute for MTC mixes, must be as, or more, effective in all situations and conditions.

4. **This CTS mix was not as effective as the MTC mixes, and generally produced a reduced level of service.**

   Data revealed that while both materials were "working", salt alone worked faster than CTS. Highways took longer to dry off, which for Durham Patrol signified a reduced level of service.

5. **This demonstration showed that the CTS mix used was not a cost-effective alternative to the MTC mixes.**

   For CTS to be equivalent in cost to MTC mixes, CTS would have to be applied at the rates shown in Table 2.

   To equate to 578 kg/2Lkm (2000 lbs/2Lm), CTS would have to be applied at 214 kg/2Lkm (760 lbs/2Lm). This rate was shown to be ineffective early in the demonstration.

   In fact, the rate of 344 kg/2Lkm (1228 lbs/2Lm) appeared to be the minimum application rate at which patrol personnel could observe satisfactory results. This 344 kg/2Lkm equated in cost to salt spread at 170 kg/2Lkm (600 lbs/2Lm), which is in excess of normal pure salt applications.

6. **Patrol personnel were of the opinion that the CTS mix was not as effective as existing mixes.**

   These experienced personnel felt that flexibility in treating various storm conditions is significantly reduced when individual sand or salt options are removed from their choice of actions.

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RECOMMENDATION:

THE DEMONSTRATION RESULTS DO NOT JUSTIFY ADOPTION OF CTS FOR MINISTRY USE.

It is not practical, from a Ministry stand-point, to use CTS, either as a primary material, or to supplement MTC materials. The CTS process requires more elaborate preparations. This necessitates additional expenditures for storage, mixing, as well as material components (washed sand).

The CTS mix acquired for this demonstration was not cost-effective when compared to the Ministry's mix.

It should be noted that the recommendation is based upon Ministry experience, and should in no way negate the CTS process for areas where material applications and service levels are such that CTS could prove cost-effective.

ACKNOWLEDGEMENTS:

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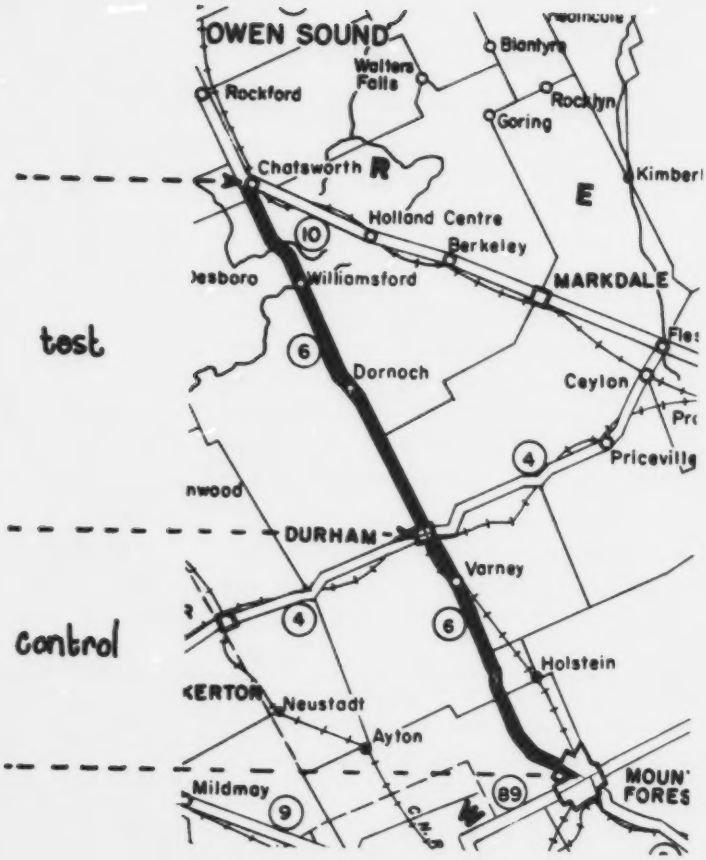
Larry MacIntosh, Shift Supvr., Durham Patrol, Owen Sound Dist.
Lorne McCannel, Shift Supvr., Durham Patrol, Owen Sound Dist.
Milton Boldt, Shift Supvr., Durham Patrol, Owen Sound Dist.

APPENDIX-I

LOCATION OF DEMONSTRATION SITE



The Patrol which best met the criteria was located at Durham, Ontario in the District of Owen Sound.

The highway selected was Hwy.6, which runs from Mount Forest at the south, to Chatsworth at the north, for a total of some 54 km.

The Patrol Yard is located at the western limits of the Town of Durham on Hwy. 4.

The test site was divided at Hwy. 4 in the Town of Durham, with the control section being from Durham southerly 23 km to Mount Forest, and the test section from Durham northerly 31 km to Chatsworth.

The highway is a hard surfaced facility, which exhibits a gradual rise in elevation from south to north, and travels through rural farm land with short sections of wooded areas.

CTS '83 DATA RECORDING SHEET - PAGE 1

DATE: _____

LOCATION T C

SITE C H T OTHER_____

TIME						
PHOTO (PIC.NO.)						
WEATHER CONDITIONS						
CLEAR						
OVERCAST						
SNOW (H,L, OR D)						H Heavy L Light D Drifting
RAIN						
FREEZING						
SLEET						
OTHER						
_____						
_____						
_____						
AIR TEMPERATURE (°C)						
WIND CONDITIONS						
NONE						
DIRECTION						N, NE, NW, S, SE, SW E, W.
VELOCITY (L,M, OR H)						L Light M Moderate H Heavy
(KM/H)						
SNOW CONDITIONS (P or N)						P Packing N not Packing

	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	
ROAD CONDITIONS											
BARE											
DRY											
WET											
SNOW COVERED											
PACKING											L Loose P Packing
DEPTH (MM)											
CENTRE BARE											
TRACK BARE											
ICY PATCHES											
ICY											
TREATMENT											
PLOW											
SAND: Rate (kg/km)											
Width (m)											
% Salt											
SALT: Rate (kg/km)											
W C											W Western E East
Width (m)											
CTS: Rate (kg/km)											
W C											
Width (m)											

CTS '83 DATA RECORDING SHEET - PAGE 2

DATE: _____

LOCATION: T C

SITE: C H T OTHER_____

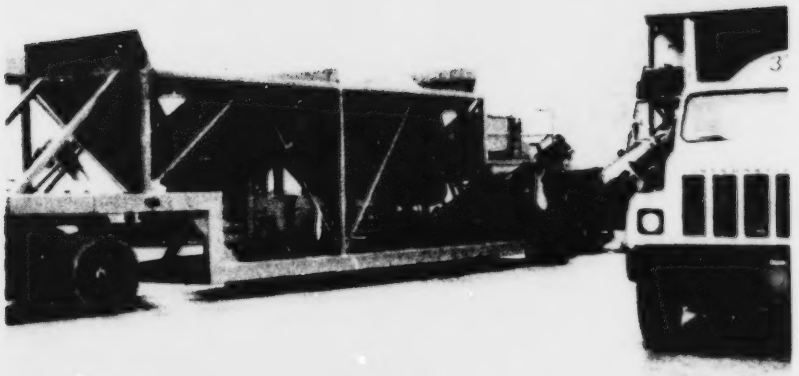
TIME					
TRAFFIC COUNT	NB SB	NB SB	NB SB	NB SB	NB SB
SURFACE TEMP (°C)					

COMMENTS

TIME	COMMENTS

APPENDIX-III

C.T.S.
MIXING METHOD



The complex looking machinery in the photo above, possesses a rather simple concept. Sand and salt placed in individual bins can be mixed in any ratio based upon the rate at which the individual materials leave their bins and fall upon a moveable belt below. This procedure can best be described as a bin/conveyor system.

Sand and salt are placed in separate hoppers. The materials are then fed onto separate, short conveyors, which revolve towards each other at different rates of speed. For this demonstration, these conveyors were set at a speed of three revolutions for sand to one revolution for salt.

From these conveyors, the materials then fall upon a medium length conveyor, which carries out the first 'mixing' of the two materials. This conveyor moves the material forward and deposits it into another small bin, which sits upon another conveyor, leading into the dome. This third conveyor is referred to as the stacker.

As the material falls into the small bin, it hits a series of curved rectangular steel plates, which contributes towards a second 'mixing' of the sand and salt.

At the apex of the stacker, a square configuration of pipe is attached, such that it surrounds the belt of the stacker at the point where the belt begins its return. Attached to this pipe is a series of nozzles on both top and bottom. A length of hose leads from the pipe to a supply of liquid calcium chloride.

The sand and salt mix is moved up the stacker, where it is sprayed with liquid calcium chloride as it leaves the stacker and falls to the pile in the dome. This constitutes a third 'mixing' of the sand and salt and is where the CTS comes into existence.

TABLE 1

OBSERVATION SITES

TEST SECTION:

Site No.	Description	Distance from Highway 4	Length of Site	Local Designation
1	Curve	4.5 km North	0.2 km	Jackson Farm
2	Hill	9.0 km North	0.3 km	Markdale Side Road
3	Tangent	15.5 km North	0.4 km	Nuhn's Garage

CONTROL SECTION:

1	Hill	4.8 km South	0.3 km	Town of Varney
2	Curve	7.1 km South	0.2 km	Mathews Property
3	Tangent	12.5 km South	0.5 km	Truck Stop Restaurant

TABLE 2

MTC & CTS MIXES
COST COMPARISONS

M.T.C. MIX				C.T.S. MIX	
Material	Application Rate (kg/2Lkm)	Salt Content (kg)	Application Cost 2/ ($ per 2Lkm)	Application Rate (kg/2Lkm)	Salt Content (kg) 1/
Sand 5%	578	28	2.62	214	41
Sand 35%	578	202	5.68	464	88
Salt 100%	130	130	3.18	259	49
Salt 100%	170	170	4.16	339	65

Notes:

1. The salt content of CTS mix was determined to be 19% by weight.
2. These costs relate only to the Durham experience, and for other situations, will vary depending upon location of sand supply, transportation costs, etc.

TABLE 3

CTS'83
SUMMARY OF SAMPLE RESULTS

Sample Number	Date Taken	Sample Location	% Cl	% Na	% Ca	% $CaCl_2$	% NaCl
1	82-10-07	Pile, various	20.2	12.5	0.60	1.70	31.5
2	10-07	Pile, various	8.0	4.0	1.07	3.00	10.1
3	10-07	Pile, middle	24.0	14.7	0.70	1.90	37.5
4	10-07	Pile, bottom	12.9	7.8	0.50	1.40	19.8
5	10-20	Pile. top	19.7	12.0	0.34	0.94	30.5
6	10-20	Pile, bottom front	23.6	15.5	0.45	1.24	31.2
7	10-20	Pile, bottom sides	2.8	0.5	0.14	0.38	4.2
10	12-01	Pile, top	5.4	3.5	0.20	0.56	8.2
11	12-01	Pile, middle	18.3	11.8	0.40	1.12	29.0
12	12-01	Pile, bottom	18.2	11.8	0.30	0.84	28.6
14	83-01-05	Pile, top	10.4	6.3	0.22	0.61	22.5
15	01-05	Pile, middle	17.4	10.8	0.35	0.97	27.7
16	01-05	Pile, bottom	15.8	10.0	0.23	0.64,	25.4
17	01-12	Spreader	7.0	4.5	0.29	0.80	10.7
18	01-18	Spreader	25.3	16.5	0.48	1.30	40.3
20 1/	01-26	Spreader	17.6	11.5	0.29	0.80	28.2
21 1/	01-26	Spreader	18.8	12.5	0.37	1.00	29.9
22 1/	01-26	Spreader	21.3	14.0	0.39	1.10	34.0
23	02-02	Spreader	10.5	6.5	0.36	1.00	16.2
24 2/	02-03	-	13.2	8.3	0.25	0.69	21.0
25	02-07	Pile, top	1.7	0.9	0.16	0.44	2.3
26	02-07	Pile, bottom	17.8	11.2	0.32	0.89	28.4
27 3/	02-07	Loader mix	13.4	8.4	0.30	0.83	21.2

Notes: 1/ Samples taken from spreader unit while spreading. Locations being at start of spread, mid-way and near the end.

2/ Sample location unknown

3/ CTS file was further mixed with a front end loader